Montana Department of Transportation

Stage 2 - Research Topic Statement

2701 Prospect Avenue
PO Box 201001
Helena, MT 59620-1001
www.mdt.mt.gov

Print Form

RESEARCH PROGRAMS USE ONLY	
RESEARCH IDEA NO:	21-012
DATE OF RECEIPT:	Apr 29, 2020
TOTAL MDT COST W/ICAP:	

RESEARCH PROGRAMS

Please submit completed forms via e-mail to MDTResearch@mt.gov. All fields are required, except the last field: XVIII, Sponsor(s). Incomplete forms will not be accepted.

TITLE (required): Artificial Intelligence (AI) based Tool to Estimate Contract Time

TOPIC STATEMENT:

MDT is required by federal regulations to have a procedure and tools for contract time determination. The contract time drives much of the contractor's approach to bidding a specific project. If the MDT sets a period that is shorter than the construction industry's estimate, bids will go up across the board as competing contractors bid the cost to accelerate the project. If the period is longer than the industry's estimate of time, the bids also go up as contractors bid the additional costs to remain mobilized. Either way, the public loses due to inaccurate and sometimes arbitrary contract completion times. Emerging Artificial Intelligence (AI) algorithms have power to process various types of data and learn the hidden patterns and make a reasonable prediction with reliable accuracy. This research project will use one of the promising AI algorithms, namely, the neural network algorithm to quickly estimate the most likely contract time for a highway project. The principle idea is to use key project characteristics that may include work type, project location, major controlling work items and their quantities of work as input variables and then, the neural network algorithm will estimate the most likely project duration or contract time of a new project by analyzing the data of the historical MDT highway projects. One of the major challenges that MDT schedulers face is the short period of time allowed for contract time determination. Thus, a quick and effective contract time determination tool that produces high-quality results in a more reliable and defensible manner will serve as a great supporting tool for improving work efficiency

RELATED RESEARCH SUMMARY FROM STAGE 1:

According to 23 Code of Federal Regulations 635.12, State Transportation Agencies should have adequate written procedures for the determination of contract time. Current practices of DOTs including MDT are typically based on a rule of thumb to determine the contract time or manual development of a bar chart schedule to compute project completion time. The current MDT Contract Time Determination (CDT) manual suggests the following process: a) identify work activities, b) estimate production rates, c) determine each activity's duration, d) develop a sequence logic, and e) creating a bar chart to compute the project duration. Studies indicated that by analyzing historical project documents, Strong correlation patterns can be found between key project characteristics and project duration that can be used to develop models as a robust alternative tool for estimating project duration of a highway project. Some DOTs including Kentucky Transportation Cabinet, Ohio DOT, and Colorado DOT applied this idea and developed data-driven statistical models for Contract time determination. They identified key project characteristics to estimate the most probable project duration including engineer's estimate, work item quantities, project type, road type, project location (urban/rural), terrain type, traffic control, and project starting season. Kentucky Transportation Cabinet was able to increase their contract time estimation accuracy by almost 5 times when they switched from traditional bar chart based methods to a data-driven statistical model. Many of the previous research studies used multivariate regression analysis to develop their models. The rise of artificial intelligence algorithms in the last decade has proven that A.I. algorithms such as Artificial Neural

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Network can perform better than multivariate regression models in term of its performance, accuracy and reliability. This research will obtain and analyze MDT historical project data and use the Artificial Neural Network as a robust technique to develop a model that can estimate the contract time of a new project with a reliable accuracy. MDT contract time developers can enhance their CTD process by using the information obtained from this model to calibrate their initial contract time estimate and the information can be used as another defensible document for justifying the contract time of a project.

RESEARCH PROPOSED:

The research goal of this study is to provide MDT with a robust decision support tool that can estimate the project duration or contract time with a reliable accuracy for a new highway project. To accomplish the goal, the following key tasks will be performed: I) Examine the currently accessible MDT historical data of project documents to extract key project characteristics that may affect contract time. Some of the potential characteristics include project type, project location, major controlling work items, and their quantities of work to be used as input variables, II) collect and analyze historical MDT highway project data that include major project characteristics, III) develop an Artificial Neural Network model that takes key project characteristics as input values and estimates the most likely project duration and contract time for a new project, IV) Develop a user-friendly Excel tool based on the ANN model. The tool will be designed to easily capture and store input variables from MDT and help users to quickly estimate the project duration of a project when key project data are entered. The most likely project duration will be estimated with a confidence level so that the information about the scheduling risk or uncertainty is known, and V) develop a guidebook and a user's manual for MDT, and VI) provide a training session for MDT engineers for immediate implementation of the tool.

RESEARCH PERIOD (Time to complete research project.):

18 months

IT COMPONENT: Identify if the project includes an IT component (purchasing of IT hardware, development of databases, acquisition of existing applications, etc.). If so, describe IT component in as much detail as possible.

The research team will need historical project data that include project attributes such as project work type, location, project size, actual project duration, engineer's estimate data including work items and their quantities, etc.

FEASIBILITY, PROBABILITY OF SUCCESS, AND RISK:

The deliverables from this research will have an immediate positive and beneficial impact on MDT. An Excel Based Tool will be useful for immediate implementation. MDT maintains historical project data that are required for this research project, thus, making this research project highly feasible. The anticipated immediate benefits create a high probability of success; therefore, this project has a low risk of failure.

URGENCY, IMPORTANCE, AND EXPECTED BENEFITS/PAY-OFF: Address urgency, timeliness, and importance of the research. Identify if the research is required for any federal or state initiative or compliance. This section must include a description of how this research will help to meet MDT's mission (i.e., serve the public by providing a transportation system and services that emphasize quality, safety, cost effectiveness, economic vitality and/or sensitivity to the environment).

Federal regulations require that each DOT must have a well-structured contract time determination procedure and tools. Inaccurate estimating of contract time will result in additionally required budget, project delay, and inconvenience to the public. This research study will provide a data-driven AI model that estimates project duration with a reliable level of accuracy. The deliverable from this project is expected to significantly help MDT meet the federal regulations and avoid the budget overrun and project delay.

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IMPLEMENTABILITY, IMPLEMENTATION PLAN, AND RESPONSIBILITY: Address the implementability of the expected results from the proposed project. Identify products that will enhance implementation. Identify any known implementation barriers and how these barriers might be eliminated or reduced. Identify MDT office or entity outside of MDT responsible for implementation. Describe initial implementation plan, include timeframe for implementation.

MDT will be able to immediately use the decision support tool that will be developed from this project to make a reliable and defensible estimation of contract time of a highway project. An accurate and reliable contract time determination will help MDT better manage their highway projects. This project will be started immediately after receiving acceptance from MDT.
The results of the study will be incorporated into the current MDT's contract time determination system and the contract time determination manual. The Highway bureau will be responsible for implementation of the research results. The implementation plan for the project is as follows:
1. Delivery of the report tools developed from the study
2. Workshop to MDT schedulers – month 1
3. Feedback from MDT – month 3
4. Update recommendations – month 6
5. Integrate into the MDT's contract time determination system and manual – month 9

MDT PRIORITY FOCUS AREAS: MDT may, as often as annually, identify priority research focus areas. These focus areas will be listed on http://www.mdt.mt.gov/research/unique/solicit.shtml.

TOTAL COST ESTIMATE (If the project proposal comes in at a higher cost, it may require further approval and may be delayed.):

$150,000

MDT FUNDING SOURCE (If MDT Research, enter SPR):

FUNDING MATCH SOURCE AND AMOUNT: $20,000

FUNDING PARTNER(S): Texas A&M University/Texas A&M Transportation Institute (TTI)

POTENTIAL TECHNICAL PANEL MEMBERS (At this time, individuals do not necessarily need to be identified; rather, MDT offices and outside entities can be named. However, if known, individuals may be named):

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